**Supporting Materials**

California Education and the Environment Initiative

# 7

**Science Standard 7.3.a.**


# Shaping Natural Systems through Evolution

**D R A F T**
**for discussion purposes only**

**California Education and the Environment Initiative**


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**California Integrated Waste Management Board**
**State Education and Environment Roundtable**
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**Heal the Bay**
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## Lesson 5 From Bananas to Prairie Chickens: How Humans Influence Evolutionary Change



## Lesson 6 Revisiting the Pupfish: Human Activities and Evolution

Name: _____

**Multiple Choice:** Select the best answer and circle the correct letter. (2 points each)

1. Which sentence about natural selection is true?
   a. Natural selection only occurs in human populations.
   b. Variations of a single trait do not naturally exist in populations.
   c. Natural variations of a single trait exist in populations.
   d. Human activities do not alter natural selection.

2. Which of these sentences about evolution is true?
   a. When species evolve, they always become more complex.
   b. Evolutionary changes rarely occur.
   c. Evolution happened in the past, but doesn't happen in the present.
   d. Evolution results in change over time of the frequency of traits in a population.

3. Which of the following applies environmental pressure on species?
   a. Changing climate
   b. The introduction of a new predator
   c. Changing the chemistry of soil
   d. All of the above

4. Which of these characteristics is an adaptation that allows pupfish to live in the desert?
   a. The ability to lay eggs when it is very hot
   b. Bright stripes
   c. The ability to tolerate cold
   d. Tails designed for fast swimming

5. Which of these sentences best describes the term "species"?
   a. All members of a species are genetically identical.
   b. Members of one species can mate with members of other species.
   c. Individuals are members of the same species if they can mate and produce fertile offspring.
   d. A single species cannot live in a variety of environments.

6. Which of these is NOT an inherited trait that would allow a species to survive or reproduce?
   a. The size of horn on bighorn sheep
   b. Having access to more food
   c. The ability to sing songs to attract mates
   d. Colors on a lizard that provide camouflage

Name: _____

**Read the following paragraph.** Answer questions 7–9 based on the reading.

> Guppies are a kind of fish that live in streams on the island of Trinidad. In some pools, guppies are very colorful. In other pools, guppies are very drab and match the color of the bottom of the pool. Guppies that stand out are more likely to find mates. Guppies that blend in are less likely to be eaten by predators.

7. According to the reading, what trait varies for these guppies?
   a. Length
   b. Speed
   c. Coloring
   d. Egg-laying behavior

8. What kinds of guppies would you expect to find in a pool that contains many predators?
   a. Mostly bright guppies
   b. Mostly drab, colorless guppies
   c. An equal mixture of bright and drab guppies
   d. There is not enough information to make a prediction

9. If you removed all the predators from a pool, how would natural selection proceed for the guppies?
   a. Bright guppies would be more likely to attract mates, so they would be more likely to reproduce. The bright-color gene's frequency would increase in future generations.
   b. Drab guppies would be more likely to survive, so they would be more likely to pass on their genes. The drab-color gene's frequency would increase in future generations.
   c. Without predators, the color of guppies would not matter for future generations. Some fish would be drab and some would be bright.
   d. Current guppies would be larger because more of their energy can now go into feeding instead of avoiding predators.

10. Which of the following statements is true if predators had a mutation that allowed them to see drab-colored guppies just as well as they could see bright-colored guppies?
    a. The guppies would need a new adaptation to avoid the predators, so they would develop one.
    b. Fewer guppies would be eaten.
    c. Being a bright colored guppy has a lower survival rate than being drab colored.
    d. Being able to avoid predation is no longer a selective advantage for drab colored guppies.

Name: _____

11. If a species does not have traits with much variation, and the environment changes, what might happen?
    a. The species may be at risk of extinction. It may not have any individuals with adaptations that help it cope with the new environment.
    b. The species can develop new adaptations on the spot, if it needs them.
    c. The species will be more successful, because all of its members can work together since they are so alike.
    d. The species will reproduce, and the new offspring will develop the adaptations needed to survive.

12. Which of the following environmental factors can influence how a species evolves?
    a. Climate
    b. Other kinds of plants and animals that live there
    c. Geography
    d. All of the above

13. Humans have dramatically changed the environment in the San Joaquin Valley in California. In this region, 95% of the land has been altered for human use. These environmental changes have:
    a. led to more species diversity.
    b. increased species' habitat range
    c. put several species at risk of extinction.
    d. had little effect on species.

**Short Answer** (3 points each)

14. Give an example of an adaptation and the environment that it evolved in.

_____

_____

_____

_____

15. Why does California have so many different kinds of species?

_____

_____

_____

_____

Name: _____

16. List three examples of human activities that have changed the environment.

_____

_____

_____

_____

_____

_____

17. Pick one of the examples above. How has this activity influenced the evolution of a species?

_____

_____

_____

_____

_____

_____

**Read the following short paragraph.** Use the information to answer questions 18–20.

Bighorn sheep live in the mountains of western North America. These sheep climb steep cliffs and graze on grass and shrubs. Male sheep, called rams, have large horns. They use these horns to fight each other. Rams exhibit a range of horn sizes. Those with the largest horns often win the fights and get to mate with female bighorn sheep. For hundreds of years, people have hunted the bighorn sheep for its meat and its horns. Hunters prize the largest horns, which they take home as trophies. Rams with the largest horns are the ones most likely to be killed.

Name: _____

18. What trait was a mating adaptation for the bighorn sheep? Why?

19. What human activity has altered evolution for the bighorn sheep?

20. Based on the reading, make a prediction. How has natural selection acted on the population of bighorn sheep since the arrival of humans?

Name: _____

Evolution is _____

This is the story of the evolution of the pupfish:

| Evolution of the Pupfish | |
|---|---|
| | |
| | |

Name: _____

## Evolution of the Pupfish Continued

| | |
|---|---|
| | |
| | |
| | |

Name: _____

## Evolution of the Pupfish Continued

| | |
|---|---|
| | |
| | |
| | |

Name: _____

| **Vocabulary** (1 point for each vocabulary word used correctly.) | |
|---|---|
| | Adaptation |
| | Environment |
| | Evolution |
| | Extinction |
| | Genes |
| | Human Activity |
| | Inherit |
| | Mutation |
| | Natural Selection |
| | Population |
| | Reproduce or reproduction |
| | Species |
| | Survive or survival |
| | Trait |
| | Variation |
| **Concepts** (2 points for a complete explanation, 1 point for a partial explanation.) | |
| | Is evolution defined and illustrated appropriately? |
| | Does the story explain how natural selection happens? |
| | Does the story explain the cause of variation and describe its role in evolution? |
| | Does the story explain one specific example of how environmental change can affect evolution? |
| | Does the story describe at least one specific example of how human activities have altered evolution for the pupfish? |
| | **Total** |

**Adaptation:** A change in the body or behavior of a species that results from natural selection due to a changing environment.

**Byproduct:** Something, such as waste materials, produced when something else is made or consumed.

**Climate:** The prevailing, average weather conditions of a particular area over time.

**Clone:** An organism that is genetically identical to its parent.

**DNA:** Deoxyribonucleic acid, the molecule that makes up the genes and carries all of the genetic information in a living thing.

**Elevation:** Height above sea level.

**Endemic:** (adjective) Living exclusively in one area, and not naturally found anywhere else.

**Evolution:** The process by which species develop over time as a result of genetic changes and resulting adaptations.

**Extinct:** No living members of a species or subspecies.

**Extinction:** The death of all members of a species or other taxa.

**Gene:** A portion of a DNA molecule that instructs the cell to make a specific protein; many traits arise from an organism's genes through a complex process.

**Gene pool:** The sum total of all of the genes in a specific group of organisms.

**Habitat:** The place where an organism lives and meets its needs.

**Heritable:** Traits that can be genetically passed from parent to offspring through inheritance.

**Human activities:** Everything that humans do.

**Inheritance:** The process by which genetic traits are passed from parents to offspring.

**Maggots:** The larval form of flies, which have a wormlike body.

**Microclimate:** The climate of a small, specific place as contrasted within the larger entire area.

**Mutation:** A change in the genetic material, or the genes, of an organism.

**Natural selection:** The process whereby individuals with favorable variations survive and reproduce more successfully and potentially resulting in the development of new types and species.

**Organism:** A living plant, animal, or other life form capable of metabolic activity and reproduction.

**Population:** Any grouping of organisms that have something in common; often, a large group of individuals of the same species.

**Protective coloration:** An adaptation in which the organism's color blends in with the environment, helping the organism to go unnoticed by predators; camouflage.

**Purebred:** Bred only from ancestors of a recognized kind over many generations.

**Reproduction:** The process an organism goes through to pass on its genes to the next generation.

**Sexual reproduction:** The form of reproduction that results in offspring who have inherited half of their genes from each parent.

**Speciation:** The process of the evolution of new species from a population of ancestors.

**Species:** Genetically related organisms that resemble one another and can successfully reproduce.

**Subspecies (abbreviation, ssp.):** A sub-classification of species that typically consists of a population isolated from the other members of the species that are similar enough to interbreed but have some distinguishing characteristics.

**Trait:** An outwardly observable characteristic, such as appearance or behavior, of an organism.

**Variation:** Differences in genetic or behavioral traits within a species.

**Vegetative propagation:** Cloning of plants, especially crops.

**Viable:** Having the potential to live, grow, develop, and function adequately.

**Wild-type:** Describes an organism that has genes and traits very similar to those of other members of the species that live in the wild.

# Pupfish

The team of divers meets at the bottom of a rocky desert hill. They climb up to a limestone cave and look down at a deep blue pool. In fact, this pool is so deep that no one has ever found the bottom. Devil's Hole is the home of the endangered Devil's Hole pupfish *(Cyprinodon diabolis)*.

The strange scene looks like something out of a science fiction movie. Twice every year, desert fish biologists meet to count the number of pupfish in Devil's Hole. They lower themselves into the warm water. They adjust their masks and scuba tanks. After descending to a depth of 80 feet, the divers slowly rise past a series of limestone shelves. They count the tiny pupfish all the way up.

Pupfish are tiny desert fishes that look a little like minnows. Most of them are about one inch long. Females are yellowish-brown on their backs, and males are blue and brown with violet-colored gills. Biologists believe that the ancestors of today's pupfish appeared 20,000 years ago. They occupied the deep inland lakes that once covered much of California. Here is how biologists believe the pupfish appeared.

Twenty-five thousand years ago, an intense uplifting and tilting of the Sierra Nevada mountain range began. Volcanoes and earthquakes thrust the existing range higher and higher. The peaks grew so high that they blocked much of the rainfall from reaching the east side of the Sierras. Over time, the large inland lakes east of the Sierras began to evaporate, and many species did not have enough habitat to survive and became extinct.

*Devil's Hole*

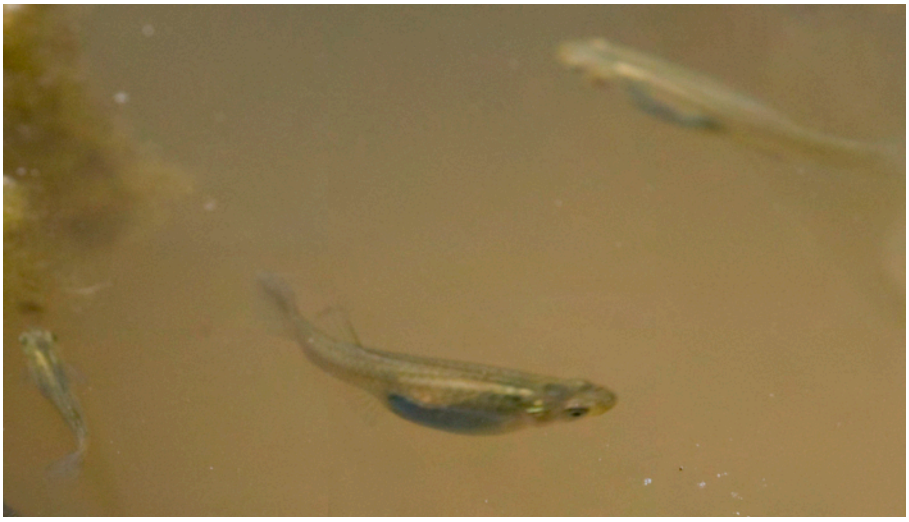
*Devil's Hole pupfish*

As the lakes evaporated, they formed many smaller ponds, resulting in small populations of pupfish that were physically isolated from each other. Only individuals that had the ability to deal with the now-harsh environment survived. These individuals reproduced, passing on these survival features to the next generation of pupfish. Because each desert environment was different, or because the individuals had different traits that allowed them to survive, each group of pupfish now has a unique set of traits.

Today, several species of pupfish are found in a few isolated ponds, creeks, and pools. Salt Creek pupfish *(Cyprinodon salinus salinus)* live in the shallow water of Salt Creek in Death Valley National Park. They are able to live in water that is three times saltier than any ocean. These pupfish hatch in the springtime, when rains fill the creek. They grow to adulthood in two to three months. When they breed, they leave their eggs in the algae of the streambed. Many of the pupfish die in the summertime, when Salt Creek dries out.

A few miles south and east of Death Valley, near Tecopa, California, the Tecopa pupfish (*Cyprinodon nevadensis calidae*) lived in the salty, warm pools. They had survived by eating algae in the 108° F water with no predators for thousands of years. Unfortunately, the owner of the hot springs in the area built canals and bathhouses for visitors in the 1940s. He brought in mosquito fish to eat the Insects that might otherwise have bothered his guests. After he built the canals, the pupfish began washing downstream. The mosquito fish ate the pupfish that did not wash away. As result, in 1970, the Tecopa pupfish was listed as endangered; by 1978, it was extinct.

Devil's Hole is 35 miles east of Death Valley, in the Amargosa Valley. From the mouth of the cavern, you look down on Ash Meadows



*Mosquito fish*

National Wildlife Refuge. The Refuge was established in 1984 to protect 13 threatened and endangered species, including the Devil's Hole pupfish. The Refuge also provides a habitat for at least 24 other species found nowhere else in the world.

There is an abundance of water in Ash Meadows. An ancient desert aquifer stretches for 100 miles just below the surface. It feeds seven major springs in the area. An underground fault acts as a dam and forces the water to the surface. This water is called *fossil water*, because geologists believe that it entered the ground around 10,000 years ago.

In the 1960s and 1970s, farmers, ranchers, and developers made a plan to use this precious desert water. They planted and irrigated crops by pumping water from the aquifer. They diverted the natural springs. All these changes influenced the natural systems in the area. Native plants, fish, and wildlife disappeared.

The tiny pupfish helped to create public awareness about the problem of water diversion. The pupfish are dependent on algae to live. In Devil's Hole, they feed and deposit their eggs on a small limestone shelf where algae grow. When the water was pumped out of the aquifer for irrigation, the water level in Devil's Hole fell below the shelf. The algae dried up and the pupfish began to die.

In 1967, the Devil's Hole pupfish was declared an endangered species. In 1969, the Desert Fishes Council brought the issue to the people. The *Save the*

*Ash Meadows National Wildlife Refuge*

*Pupfish* slogan could be seen everywhere, from bumper stickers to store windows. In 1972, the people of the United States brought a lawsuit against land developers and the State of Nevada. The case went all the way to the Supreme Court. Eventually the Court ruled in favor of the pupfish. It established a minimum water level that had to be maintained.

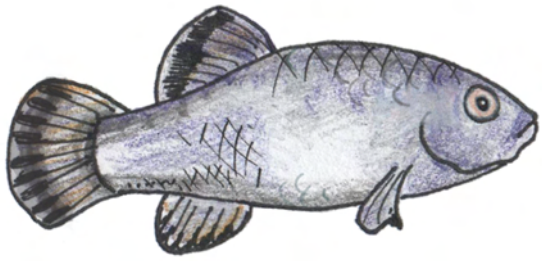
Until 2005, the population of pupfish in Devil's Hole had either grown or remained stable. The divers counted 300–500 pupfish in 1995. In the fall of 2005, however, the count suddenly dropped to 85. By the next spring, it was under 40. What happened to the pupfish? Fish biologists do not know. They are again studying the environment to understand why the population decreased.

Biologists know that genetic variation in the pupfish allowed it to survive geological changes 10,000 years ago. Since then, however, this very small population of pupfish has existed in complete isolation and has had few predators. There was little change in the pupfish's environment until the late 1960s. For all these reasons, biologists think that this small, isolated population may have very little genetic variation. If this is correct, then it may be that no individuals have the inherited traits that would enable them to survive changes in the environment.

*Scientists at Ash Meadows National Wildlife Refuge*

The divers slowly return to the surface of Devil's Hole. They push up their masks and talk to one another about how many pupfish they found. One of the fish experts is still leaning over the spawning shelf, counting the fish one last time. When the verdict is in, there are 38 pupfish in the warm clear pool. This is the same number as last year. Even though the number is low, the divers sigh with relief. They are expecting that the pupfish count will be higher in the fall.

Pupfish provide an excellent example of how evolution occurs, especially in isolated populations. The disappearing pupfish at Devil's Hole are causing experts to ask how changing environmental factors affect species that are thousands of years old. This year, they will be checking water quality, nutrients, and studying the way that the angle of the sun affects the growth of algae in the pool. They are also looking at raising Devil's Hole pupfish in the laboratory, in order to protect this rare little fish from extinction.

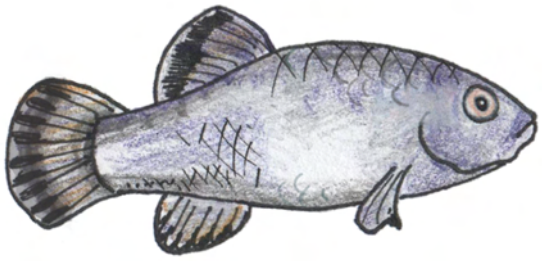


## Fish A

**Salinity:** Can survive in low to high salinity

**Temperature for laying eggs:** Can survive and lay eggs at low and high temperatures

**Breeding habits:** Lays eggs in the spring. These eggs can remain in algae when water levels go down and hatch when water levels return the next year.

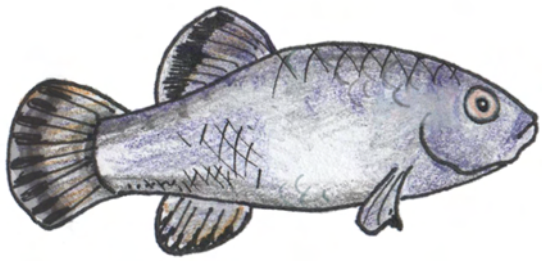


## Fish B

**Salinity:** Can survive in low to high salinity

**Temperature for laying eggs:** Can lay eggs only at 75–86° F (24–30° C)

**Breeding habits:** Lays eggs year-round

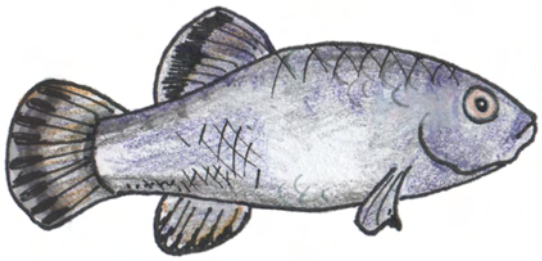


## Fish C

**Salinity:** Can survive in low to medium salinity

**Temperature for laying eggs:** Can lay eggs at low and high temperatures

**Breeding habits:** Lays eggs year-round.

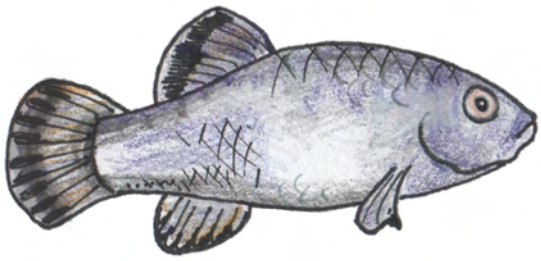


## Fish D

**Salinity:** Can survive in low to medium salinity

**Temperature for laying eggs:** Can lay eggs only at 75–86° F (24–30° C)

**Breeding habits:** Lays eggs in the spring. These eggs can remain in algae when water levels go down and hatch when water levels return the next year.

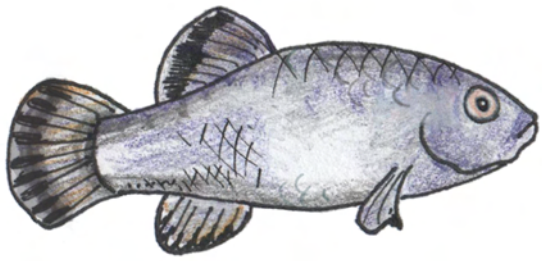


## Fish E

**Salinity:** Can survive in fresh water with low salinity

**Temperature for laying eggs:** Can lay eggs at low and high temperatures

**Breeding habits:** Lays eggs year-round.

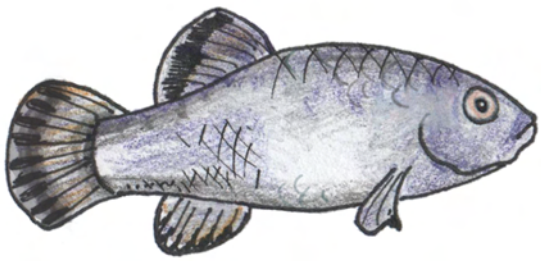


## Fish F

**Salinity:** Can survive in fresh water with low salinity

**Temperature for laying eggs:** Can lay eggs at low and high temperatures

**Breeding habits:** Lays eggs in the spring. These eggs can remain in algae when water levels go down and hatch when water levels return the next year.

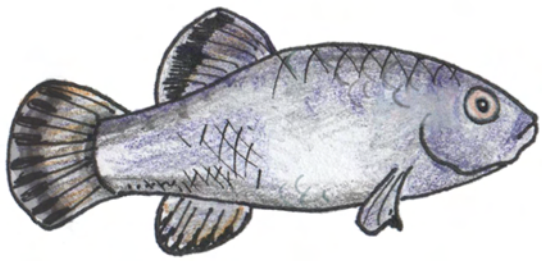


## Fish G

**Salinity:** Can survive in fresh water with low salinity

**Temperature for laying eggs:** Can lay eggs only at 75–86° F (24–30° C)

**Breeding habits:** Lays eggs year-round.



## Fish H

**Salinity:** Can survive in fresh water with low salinity

**Temperature for laying eggs:** Can lay eggs only at 75–86° F (24–30° C)

**Breeding habits:** Lays eggs in the spring. These eggs can remain in algae when water levels go down and hatch when water levels return the next year.

Name: _____

## **Part I:** Different traits

The fish on your table represent different members of one species of pupfish. These fish lived 25,000 years ago. (2 points each)

1. List three different traits that can be used to describe a pupfish.

_____

_____

_____

2. Human beings are all members of the same species, but individuals of the species have different traits. List three traits that a person might have that can be different for in another individual in this species.

_____

_____

## **Part II:** How individuals survive and reproduce in different environments

Use your environment card and fish to help answer the questions below. (2 points each)

**Environment #1:**

1. What is the name of the environment?

_____

2. Describe this environment.

_____

_____

_____

3. Which fish will not survive in this environment, if any? Why?

_____

_____

_____

Name: _____

4. Of the fish that will survive, which will be the most successful at reproducing? Why?

5. A fish that survives and reproduces passes on its traits to its offspring. What trait or traits are most likely to be passed on in this environment?

**Environment #2:**

1. What is the name of the environment?

2. Describe this environment.

3. Which fish will not survive in this environment, if any? Why?

4. Of the fish that will survive, which will be the most successful at reproducing? Why?

5. A fish that survives and reproduces passes on its traits to its offspring. What trait or traits are most likely to be passed on in this environment?

Name: _____

**Environment #3:**

1. What is the name of the environment?

2. Describe this environment.

3. Which fish will not survive in this environment, if any? Why?

4. Of the fish that will survive, which will be the most successful at reproducing? Why?

5. A fish that survives and reproduces passes on its traits to its offspring. What trait or traits are most likely to be passed on in this environment?

## **Part III:** Summary

Complete the following. (2 points each)

1. Define adaptation in your own words.

Name: _____

2. What is an example of an adaptation in one of the pupfish from Part 2?

3. Define natural selection in your own words.

4. Define evolution in your own words.

5. What makes a trait become more common in future generations?

6. If a trait makes an organism more likely to survive, will it always be passed on to future generations? Why or why not?

## #1 Amargosa River

The Amargosa River runs through a canyon east of Death Valley. Its name is a bit misleading, as this river is actually a small stream less than 2 meters wide and about 2.5 meters deep. The water in this part of the river is in constant motion year-round. Water temperatures in the Amargosa River range from 35–112° F (2–44° C) during the year. The temperature also changes significantly during a single day. Water at night can be over 60 degrees cooler than it is in the morning. The salinity (amount of salt in the water) is moderate.

## #2 Big Spring

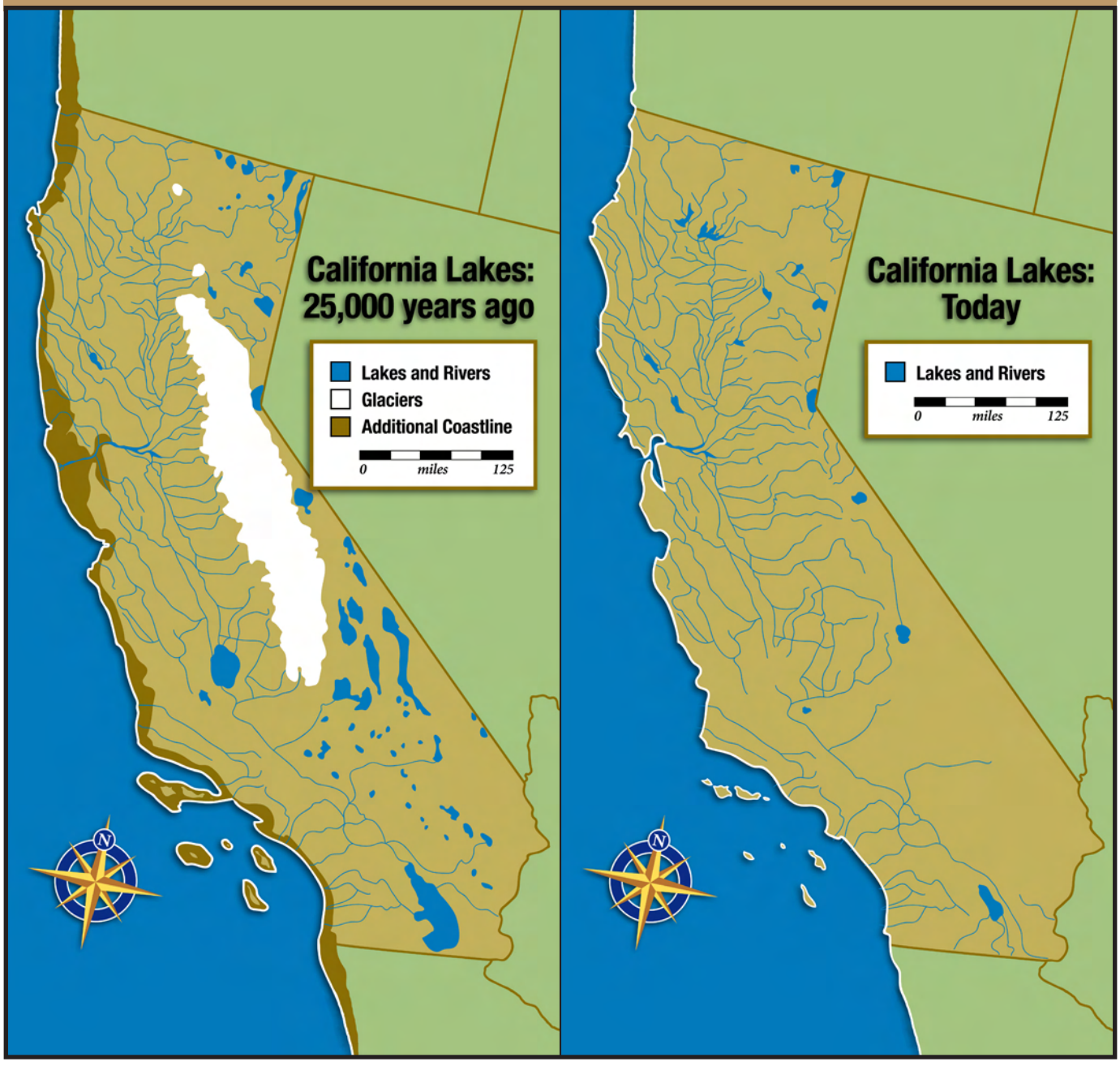
Big Spring is located in the Ash Meadows National Wildlife Preserve in Nevada. It is just across the state border from California. Here, water rises up from underground to form a pool. The size of this spring is relatively stable. The salinity (amount of salt in the water) is very low. Big Spring stays at a mostly constant temperature, around 80–90° F (27–32° C).

## #3 Salt Creek in Death Valley

Salt Creek is a small stream on the floor of Death Valley. Part of the stream dries up during summer and fall. Salt Creek is two to three times saltier than ocean water. Water temperature varies greatly, from freezing to temperatures over 110° F (43° C).

# Pupfish

# California Lakes: Then and Now



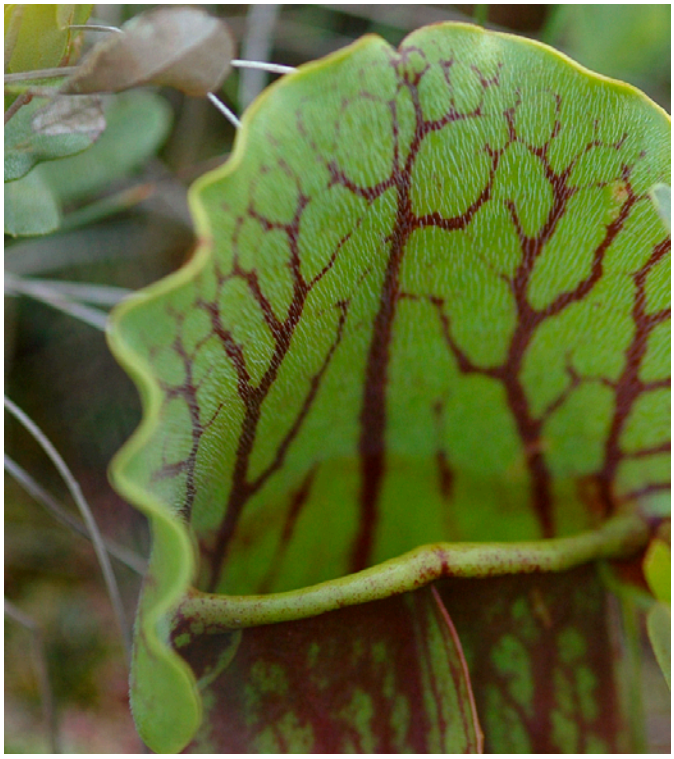
Name: _____

**Instructions:** Complete the chart below. (1 point for each cell)

| | Research Project 1: Purple Pitcher Plant Mosquitoes | Research Project 2: Kauai Field Crickets | Research Project 3: *E. coli* bacteria | Research Project 4: Guppies |
|---|---|---|---|---|
| **What trait did the researchers study?** | | | | |
| **How did this trait vary in the population?** | | | | |
| **What environmental condition or environmental change put selection pressure on this trait?** | | | | |
| **Which version of the trait is most adaptive for this environment?** | | | | |
| **Why is this variation of the trait considered an adaptation?** | | | | |
| **How has the population evolved over time?** | | | | |

## Purple Pitcher Plant Mosquito:

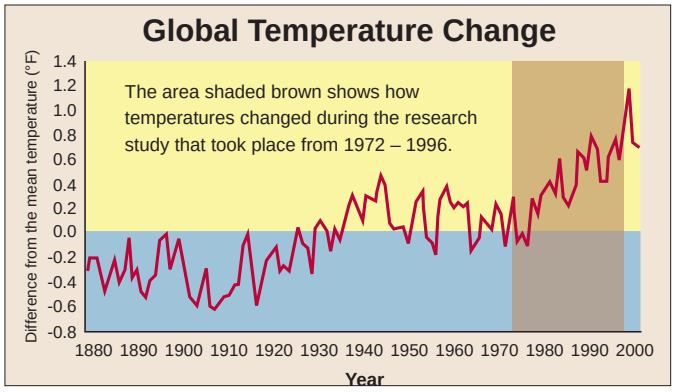
This non-biting mosquito lives its entire life on a purple pitcher plant. These mosquitoes are found in the northeastern United States, and they hibernate during the winters, which can be quite cold in that part of the country. Several genes control the timing of the onset of hibernation in mosquitoes. The length of the day, not temperature, is the cue for hibernation to begin. The timing of the onset of hibernation is critical to the mosquito's survival; if hibernation is begun too early, the mosquito will not have enough nutrients stored in its body to last throughout the winter. On the other hand, if it delays the beginning of hibernation for too long, it will freeze to death. The mosquito most likely to survive and reproduce is the one whose hibernation begins at just the right time—the one that has the most time to eat before hibernating but does not freeze to death.



*Purple pitcher plant*

## What the Scientists Found:

Christina Holzapfel and her husband William Bradshaw are biologists. They have been collecting and examining mosquitoes from New England for over 30 years. They noticed two important changes during that time. In New England, winter temperatures went up by an average of 4.4° F (15.3° C). That means that mosquitoes could eat and reproduce later into the year. The behavior of the mosquitoes also changed: they began to hibernate, on average, 9 days later.




*Purple pitcher plant mosquito*

## Kauai Field Cricket:

Field crickets live on the island of Kauai in Hawaii. Male crickets have small scrapers on their wings. Rubbing the wings together makes a chirping sound that attracts female crickets to mate; but the chirping also attracts flies. A deadly fly called *Ormia ochracea* recently arrived in Kauai from North America. It lays its eggs on the bodies of the field crickets, and the eggs develop into maggots (the larvae of the fly). These burrow into the body of the cricket to eat, killing the cricket in the process.

*Normal Kauai field cricket*

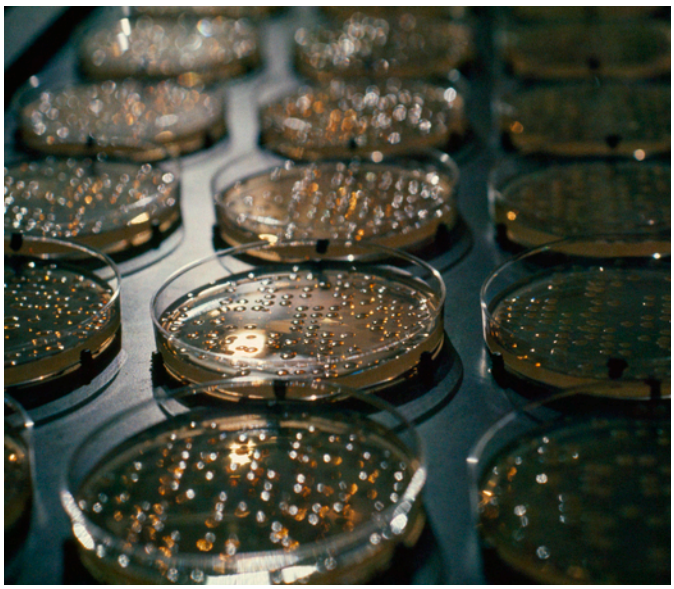
## What the Scientists Found:

Marlene Zuk is a Professor of Biology at the University of California, Riverside. In 1991, she began studying field crickets in Kauai, and she found that the size of their population dropped every year. By 2001, there were hardly any crickets left, because most of them had been eaten by the maggots of the fly that had been introduced onto the island. However, a new mutation appeared in the cricket population that resulted in some male crickets having flat wings. These wings could not make a chirping sound. Male crickets depend upon “singing”, the chirping sound made by their wings, to attract females during mating season. But even though this mutation and new trait made it more difficult to mate, it protected these silent male crickets from the flies by making it more difficult for the flies to find them. By 2003, over 90% of male crickets had flat, silent wings. Scientists believe that mutant males gather near male crickets that can still sing so that females can find and mate with them.

*Flatwing Kauai field cricket*

## *Eschericia coli (E. coli):*

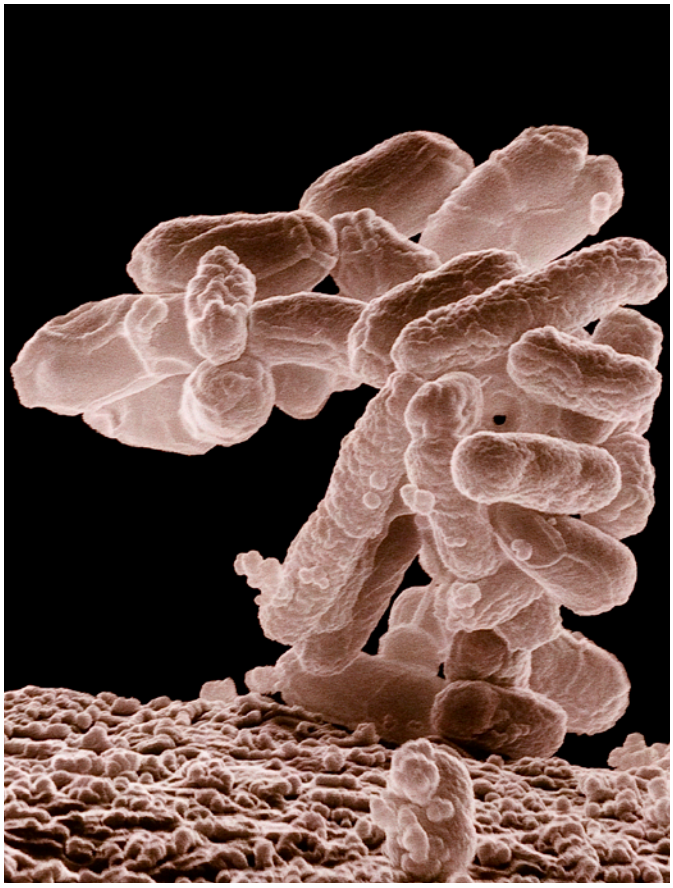
*E. coli* is a kind of bacteria that often grows in the lower intestines of animals. It can also be grown easily in Petri dishes in laboratories, and it reproduces rapidly. In a laboratory setting, *E. coli* eat glucose, a kind of sugar. Other kinds of nutrients are also put in Petri dishes, though *E. coli* usually cannot use them.



*Petri dishes*

## What the Scientists Found:

Richard Lenski is a Biologist at Michigan State University. Twenty years ago, he took a single *E. coli* cell, fed it, and watched it reproduce. He paid attention to what kinds of food the bacteria could use. He continued to feed the next generation of bacteria, and the next. From that first cell, he has now grown over 44,000 generations of bacteria. Each generation exhibited new genetic mutations. In the 31,500$^{th}$ generation, Lenski noticed something new about his bacteria. Some of them had a genetic mutation that allowed them to use a nutrient called citrate. His first *E. coli* could not use citrate, but these new bacteria could. The bacteria with this trait began to increase in his laboratory population.



*E. coli*

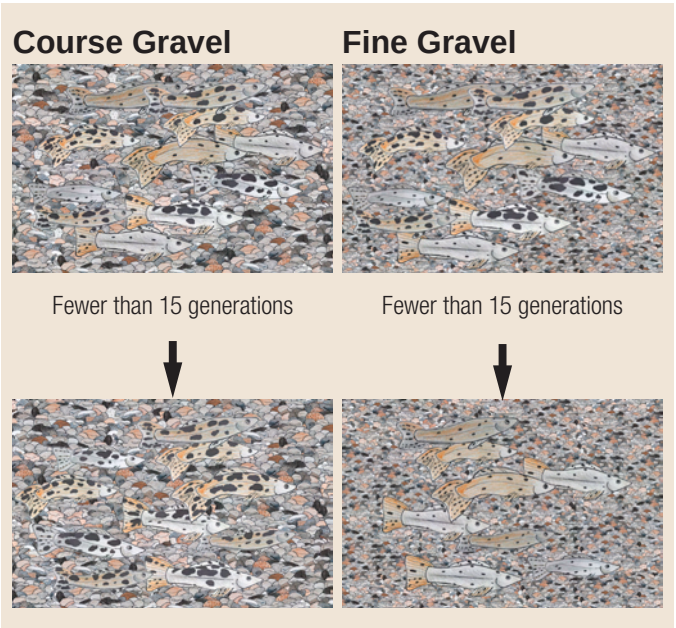
## Guppies:

Some guppies live in pools and streams in the island of Trinidad. Different parts of each stream contain different-looking guppies. Some pools are full of fish with bright colors or spots that stand out against the bottom of the pool. Others contain rather drab guppies that are camouflaged against the bottom of the pool. Guppies that are brightly colored or show up well in their pool are more likely to attract mates. Guppies that do not stand out are less likely to be eaten by predators.

*Guppy*

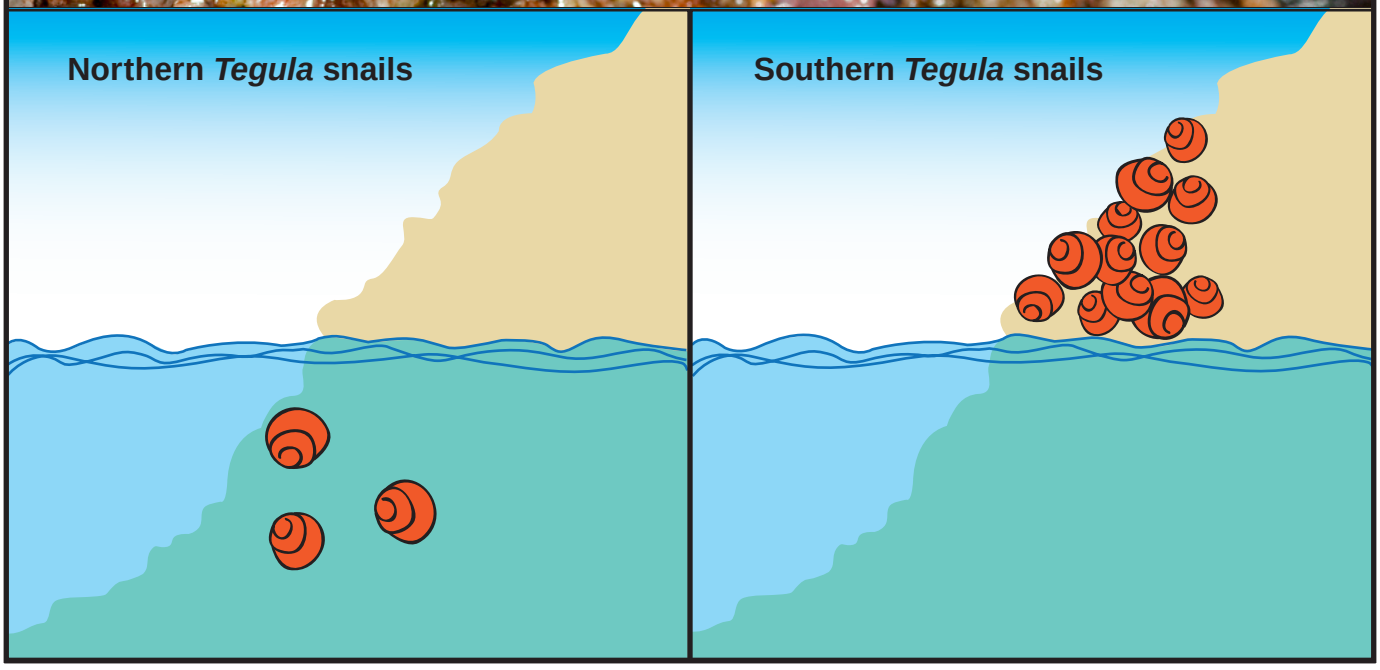
## What the Scientists Found:

Biologist John Endler studies guppies in the wild and in the laboratory. Endler thought that guppies with spots that were noticeable against the colors of the pool would have more success in attracting mates. He also realized that noticeable spots would probably make the guppy more noticeable to predators. But in pools with an absence of predators, he wondered if guppy populations would have a higher number of individuals with those spots, because of the advantage the spots would give the guppy at mating time. In order to answer this question, he conducted an experiment. He put guppies into two tanks; some of the guppies had smaller spots and others had larger ones. One tank had coarse gravel at the bottom and the other had fine gravel. Then he waited. After fewer than 15 generations, the overall appearance of the guppy populations in each tank changed. Endler's setup kept the guppies free from predators, and population evolved spots that made the fish show up well against the bottom of the pool. This finding confirmed Endler's idea that, in the absence of predators, the guppies that were the easiest to see were more likely to attract mates and pass on their genes.




*Guppy adaptation*

# Tegula Snail Research

# Evolution Notes

## Variation

A population of organisms displays variety in inherited traits.

If the genes for a trait do not exist in a population, that trait cannot be selected.

Genetic mutations result in different new traits (some good, some bad, some with no effect).

Mutations are random, but selection of their traits expressed in a population is not random.

## Environment

In certain environments, some traits are more useful than others.

Those traits that are favorable in that environment are adaptations.

Adaptations allow an organism to survive and reproduce in a particular environment.

When an environment changes (due to human activities, natural disasters, and more), the traits that are adaptive and get selected may change.

## Natural Selection

A trait is more likely to be passed on to the next generation when it helps the organism to:

- Survive (avoid predators; find food)
- Find a mate
- Reproduce

Traits that help an organism to do these three things are more likely to be found in more offspring in subsequent populations.

Name: _____

## Round 1 Data Collection

Environmental conditions: It has been an average weather season in Origami Bird Land. There has been a mix of food types, both large and small.

| Name of bird (student) | Small or large beak? | Number of rice grains eaten | Number of marbles eaten | Did it survive? | How many offspring did it have? |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

After Round 1, there were: _____ small-beaked birds _____ large-beaked birds

## Round 2 Data Collection

Environmental conditions: It has been a very wet season in Origami Bird Land. Small seeds (rice) are very plentiful. There are few large, dry seeds (marbles).

| Name of bird (student) | Small or large beak? | Number of rice grains eaten | Number of marbles eaten | Did it survive? | How many offspring did it have? |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

After Round 2, there were: _____ small-beaked birds _____ large-beaked birds

Name: _____

## Round 3 Data Collection

Environmental conditions: It has been a very dry season in Origami Bird Land. There are mainly large, dry seeds (marbles); almost all of the small ones (rice) are gone.

| Name of bird (student) | Small or large beak? | Number of rice grains eaten | Number of marbles eaten | Did it survive? | How many offspring did it have? |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

After Round 3, there were: _____ small-beaked birds _____ large-beaked birds

## Round 4 Data Collection

Environmental conditions: _____

| Name of bird (student) | Small or large beak? | Number of rice grains eaten | Number of marbles eaten | Did it survive? | How many offspring did it have? |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

After Round 4, there were: _____ small-beaked birds _____ large-beaked birds

Name: _____

## Analysis Questions (2 points each):

1. What kinds of birds survived and reproduced in a rainy climate? Which reproduced the most?

2. What kinds of birds survived and reproduced in a dry climate? Which reproduced the most?

3. What would happen if there were only small-beaked birds in a dry climate? Why?

Name: _____

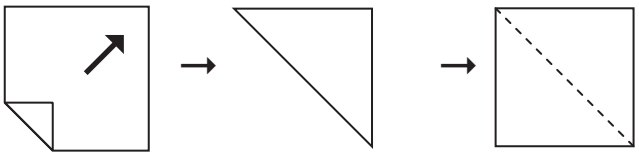
4. If the only kinds of food available were very large (larger than the marbles), what would happen to the bird population that existed at the end of Round 2? Why?

5. If the only kinds of food available were very large (larger than the marbles), what would happen to the bird population after Round 4? Why?

6. Is there a “best” kind of bird beak? Why or why not?

Name: _____

**Step 1**:



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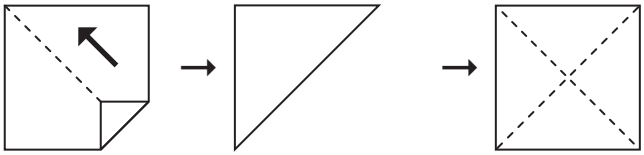

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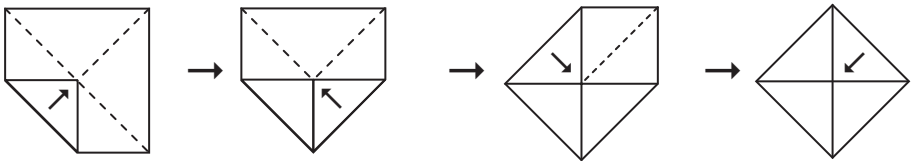

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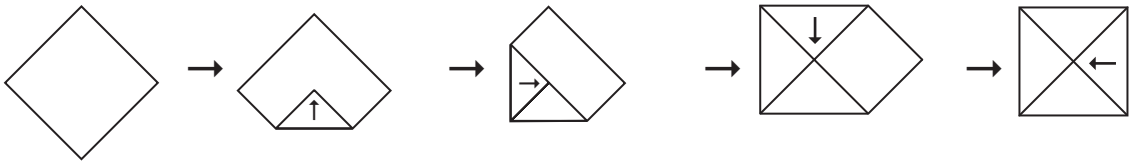

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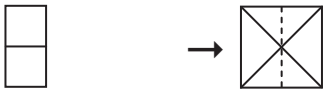

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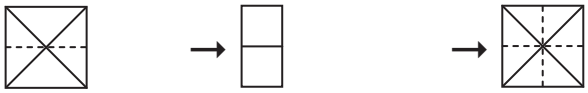

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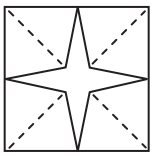
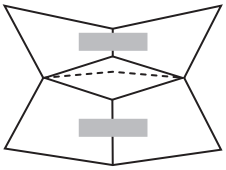


**Step 8:**



At this point, each student should have a bird beak that can be opened and closed.

# Darwin's Finches

**Semi-arid, steppe (hot):** The temperatures in this climate are high. It is hot and dry, but has more moisture than a desert— enough to support grasslands and other kinds of plants.

**Semi-arid, steppe:** The temperatures in this climate range on the high end. Temperatures rarely drop below freezing. It is warm but not hot. While it is dry, it has more moisture than a desert— enough to support grasslands and other kinds of plants.

**Semi-arid, steppe w/summer fog:** The temperature in this climate is mild. It rarely drops below freezing. It is dry, but it has more moisture than a desert, enough to support grasslands and other kinds of plants. This climate also has frequent fog in the summer.

**Arid low-latitude desert (hot):** This climate is extremely dry most of the year. Temperatures can become very high, especially during the summer.

**Arid mid-latitude desert:** This climate is extremely dry most of the year. Temperatures are lower than in low-latitude desert.

**Mediterranean/hot summer:** Mediterranean climates have mild temperatures and seasonal rains. In this climate, summers are hot and winters are cool. It rarely freezes. Most of the precipitation falls in the wintertime. Summers are very dry.

**Mediterranean/cool summer:** Mediterranean climates have mild temperatures and seasonal rains. In this climate, summers are cool and winters are cool. It rarely freezes. Most of the precipitation falls in the winter. Summers are very dry.

**Mediterranean/summer fog:** Mediterranean climates have mild temperatures and seasonal rains. In this climate, summers are cool and winters are cool. It rarely freezes. Most of the precipitation falls in the wintertime. Summers are very dry. This climate also has frequent summer fog.

**Cool continental/dry summer:** This climate features cold winters and cool summers. It gets moderate amounts of rain and snow, though most of the precipitation falls in the winter.

**Cold winter/dry summer:** This climate features cold winters and cool summers. Summers are also very short. It gets moderate amounts of rain and snow, though most of the precipitation falls in the winter.

**Highland/Timberline:** This climate is altered by very high altitude. It features cold winters and cool, short summers. Most of the precipitation falls in the winter.

Name: _____

## Part I. Environments

Use the chart below to describe these different environments in California. For each row:

1. Use the latitude and longitude to find the location on the **Political** map.
2. Use the colors on the map to find the elevation at this location. Describe the elevation using the categories "low," "medium," "high," or "very high."
3. Use the "Geographic Regions of California" map on the **Political** map to determine the name of the region of this location. Describe whether the geology of this region contains mountains, valleys, or deserts, or whether it is on the coast.
4. Use the **Climatic Zones Map** to find the climatic zone for this location. Use your **Glossary** to learn what each zone means. Describe the climatic zone in your own words.

| **Location** | **Elevation:**<br>Low = 0-1,000 feet<br>Medium = 1,000–5,000 feet<br>High = 5,000–10,000 feet<br>Very High = over 10,000 feet | **Geographical Region**:<br>List the name and describe it (mountains, valley, desert, coast) | **Climate**:<br>Describe the climate. |
|---|---|---|---|
| **Orick**<br>(41.3° N, 124.1° W) | | | |
| **Yosemite Village**<br>(37.7° N, 119.6° W) | | | |
| **Preston Peak**<br>(41.8° N, 122.6° W) | | | |
| **Forestville**<br>(38.5° N, 122.9° W) | | | |
| **Madera**<br>(36.9° N, 120.1° W) | | | |
| **White Mountain Peak**<br>(37.6° N, 118.3° W) | | | |
| **Blythe**<br>(33.6° N, 114.6° W) | | | |
| **Redondo Beach**<br>(33.8° N, 118.4° W) | | | |

Name: _____

## Part II. Matching

Read the description of each plant or animal on the **California Species Descriptions**. Look at what adaptations these species have. Think about what environmental pressures would cause these adaptations to be selected over time. Match each species with its correct environment. Put the letter of the matching location next to the correct species.

American pikas live near Location _____

Blunt-nosed lizards live near Location _____

Desert kangaroo rats live near Location _____

El Segundo blue butterflies live near Location _____

Coastal redwoods live near Location _____

Giant sequoias live near Location _____

McDonald's rockcress lives near Location _____

Pitkin's marsh lilies live near Location _____

A. Blythe

B. Forestville

C. Madera

D. Orick

E. Preston Peak

F. Redondo Beach

G. White Mountain Peak

H. Yosemite Village

## Part III. Analysis

1. Pick a species from the list above and answer the questions below about that species.

_____

What is an adaptation that this species has? (2 points)

_____

_____

_____

_____

What kind of environmental factor would exert selection pressure for this trait and make the trait adaptive? (2 points)

_____

_____

_____

_____

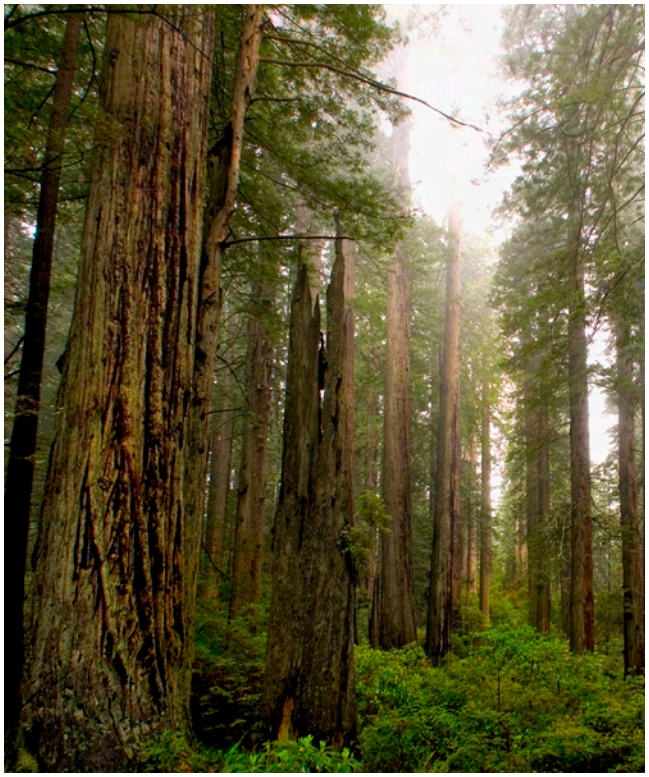
Name: _____

2. Why does California have so many different kinds of species? (2 points)

Many of the species you studied today live in environments that are changing. Read about each change below. Think about what you know about evolution, and predict what you think could happen to this species in response to this change.

3. Temperatures at very high elevations have been getting warmer. How do you think this could affect the evolution of the American Pika? (2 points)

4. Scientists have been planting more coastal buckwheat on beaches. How do you think this could affect the El Segundo blue butterfly? (2 points)



*Redwoods*

## The Coastal Redwood
(*Sequoia sempervirens*)

The coastal redwood is the tallest species in the world, reaching heights of over 300 feet. This tree requires a year-round supply of water, either from the soil or from the air. One unique feature of this tree is that it can absorb water from fog through its needles. Scientists estimate that the coastal redwood gets 30–40% of its water from fog. It requires rich soil to survive, and cannot tolerate salt spray from the ocean. It also does not grow at altitudes much higher than 2,000 feet.

*Giant Sequoia*

## The Giant Sequoia
*(Sequoiadendron giganteum)*

As its name suggests, the giant sequoia is one of the largest tree species in the world. These trees are also known for their age. Many trees alive today are 2,000–3,000 years old. Giant sequoias require moderate amounts of water to survive. They can survive in cold temperatures, down to about -12° F (-24° C). Above 9,000 feet, temperatures become too extreme for the trees. They also cannot survive at elevations lower than 2,700 feet, as these lower areas tend to have less water for the trees. Large giant sequoias have thick bark that allows them to survive fires that occur in dry summers. In fact, these trees need fires as a means to remove other trees that make shade. Young giant sequoias need lots of direct sunlight to grow and cannot survive in the shade.

*McDonald's Rockcress*

## McDonald's Rockcress
(*Arabis Macdonaldiana)*

McDonald's rockcress is a plant with vibrant, lavender-colored flowers. It grows in soils rich in serpentine, which is California's state rock. This rock is formed when tectonic plates meet, as they do in the mountains of Central and Northern California. Serpentine contains high amounts of metals. McDonald's rockcress has a high tolerance for these metals, which few plants can tolerate. This plant survives well in a mild, cool climate and can tolerate dry summers. It also needs a moderate amount of water to survive.

*Pitkin's Marsh Lily*

## Pitkin's Marsh Lily
*(Lilium pardalinum ssp. pitkinense)*

Pitkin's Marsh Lily is known for its beautiful flowers. Petals are red on the outside, yellow near the center, and covered with small deep maroon dots. This lily grows in moist, sandy soils in freshwater marshes. It gets its water from the soil near marshes, so it can survive dry summers, provided that the marsh does not disappear. These flowers survive best in mild climates where it can avoid extremes of temperature (neither too cold nor too hot). It grows only at low altitudes in the range of 35−60m above sea level. (The "*ssp.*" in the flower's scientific name stands for "subspecies"—a group within a species that appears or behaves differently from other groups within that same species.)

*Blunt-nosed Leopard Lizard*

## Blunt-nosed Leopard Lizard
(*Gambelia sila*)

The blunt-nosed leopard lizard comes in a variety of colors, depending on the kind of soil or plants it lives on. These lizards have very specific temperature needs, and are rarely active when it gets colder than 70° F (21° C). By autumn, blunt-nosed leopard lizards enter burrows to keep warm, and there they hibernate until spring. They cannot tolerate extremely hot temperatures. They cannot live in places with lots of plants, though they do use some plants to help them hide from predators. Too much water puts them at risk of drowning in floods.

*American Pika*

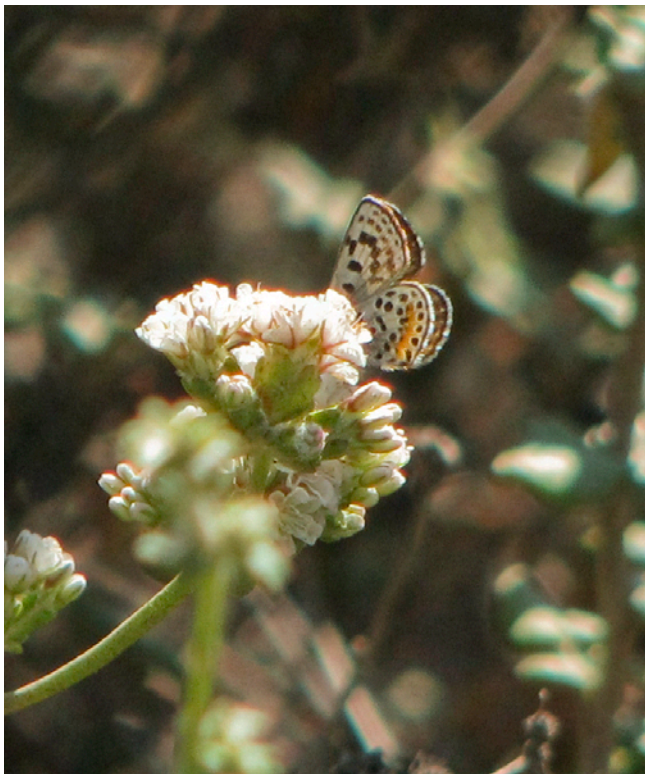
## American Pika
(*Ochotona princeps*)

The American pika is a tiny, round mammal with some similarities to a rabbit. It weighs less than ½ pound. The pika has a dense fur coat that allows it survive in cold, moist climates. It spends short summers collecting grasses and wildflowers to eat during long winters. The pika dries the plants, then stores the food in “hay piles” deep beneath the rocks. It spends winters beneath the rocks, though it does not hibernate. The pika has the lowest tolerance for heat of any mammal. If temperatures reach about 77° F, the animal will die if it doesn’t reach a cool space under a rock. Pikas cannot live if summers are hot, because they are not able to go out in the heat to find food that they would need to survive the winter. Pikas live at elevations of 8,000–13,000 feet, where the temperatures are more likely to stay cool.

*Desert Kangaroo Rat*

## Desert Kangaroo Rat
*(Dipodomys deserti)*

The desert kangaroo rat is a small rodent. It has several adaptations to help it survive in a hot climate with extremely limited water supplies. This rat collects dry seeds to eat, but it also can extract water out of the seeds to quench its thirst. It also has special kidneys that remove waste from the body without using much liquid. To save water, the rat doesn't sweat or pant. It stays in burrows during the heat of the day to stay cool. The desert kangaroo rat only comes out at night when the temperature is cool. All of these traits allow this rodent to live in a very hot environment where there is little water.

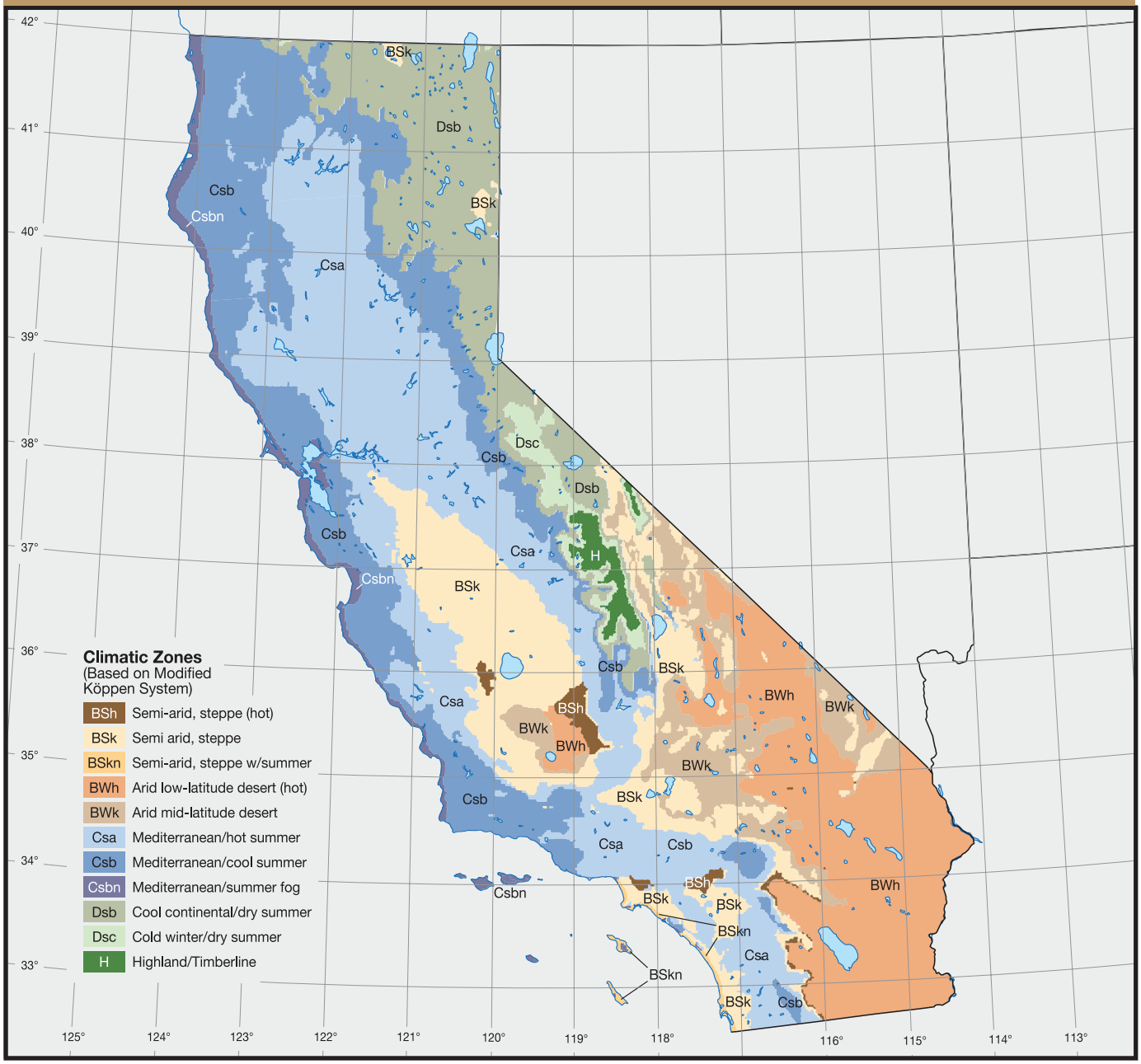


*El Segundo Blue Buttefly*

## El Segundo Blue Butterfly
(*Euphilotes battoides allyni)*

The El Segundo blue butterfly is a tiny insect about 1 inch across. It lives its entire life on one kind of plant called coastal buckwheat, which grows in the sand dunes of beaches. The butterfly's life cycle matches that of the buckwheat. When the warm, dry summer arrives, coastal buckwheat begins to flower. That's when the El Segundo blue butterfly emerges from its cocoon. It lives for only a few days as a butterfly, just long enough to lay eggs on the coastal buckwheat. About a week later, caterpillars emerge from the eggs. They feast on the coastal buckwheat for a month, then form cocoons. Here the El Segundo blue butterfly remains until the next summer, when the buckwheat flowers again. The coastal buckwheat, which does not require much water itself, provides the butterfly with all the moisture it needs to survive. Mild temperatures are needed for both the butterfly and the coastal buckwheat.

# Climatic Zone Map



# Greater Prairie Chicken

The Greater prairie chicken was once very common in North America. These prairie chickens aren't the same as chickens that people raise for food. They are a wild species that live in the tall grasses of the prairies. Male birds have distinctive golden pouches on the sides of their necks. They inflate these pouches to attract females. The population of prairie chickens has disappeared in Canada and dropped significantly in the United States over the past 100 years.

Tall grass prairies used to cover 400,000 square miles of land in the United States. This is equivalent to 15% of the land in the lower 48 states. Since the 19th century, farmers have cleared these prairies to create farms. Only 5% of the tall grass prairies still exist in the United States.

As tall grass prairies have disappeared, so have prairie chickens. Lack of habitat has forced birds into smaller geographic areas. Small populations of these birds still exist, though they are isolated from one another. One study of prairie chickens in Illinois highlights this. In 1933, 25,000 prairie chickens lived in Illinois. By 1962, 2000 birds lived in one of three groups. By 1994, fewer than 50 birds remained. All of the offspring in present day populations have come from those remaining 50 birds. With so few birds reproducing, there is a smaller variety of genes to be passed on. As a result, offspring have very similar traits.

Having such a small gene pool has posed a problem for this bird species. If a harmful gene exists in one bird, it often exists in others, because all of the birds are genetically similar. Two mating birds can both pass on copies of this harmful gene to offspring. Inheriting the harmful gene from both parents can prevent eggs from hatching. This causes populations of prairie chickens to have lower hatch rates. (A hatch rate is the percentage of eggs that hatch successfully.) In 1990, the hatch rate in the prairie chicken populations was only 38%. Looking at it another way, 62% of the eggs that the birds laid had harmful combinations of genes and could not survive.

Scientists predicted that the prairie chickens in Illinois could not survive without introducing a greater variety of genes into the gene pool. They brought birds from Kansas and Minnesota to add to the three groups in Illinois. After this intervention, the hatch rate increased. The population of prairie chickens in Illinois has started to grow again.

*Greater prairie chicken*

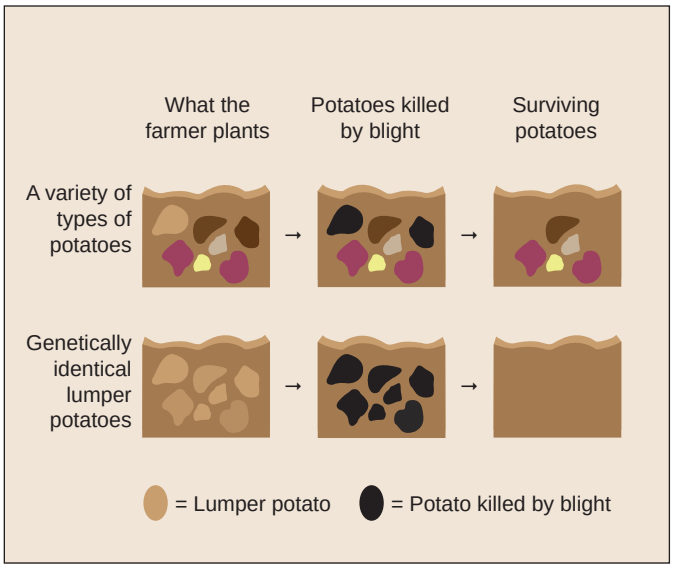
# Lumper Potatoes

In the early 1800s, Ireland's population grew rapidly. In order to feed increasing numbers of people, farmers began to change the way they farmed. A type of potato known as the "lumper" became very popular. While this potato was one of the worst-tasting potatoes around, it was very fertile. An entire family could feed itself for a year on just a small plot of lumpers. The poor people of Ireland did not have much land for farming. They used the little land they did have to grow lumper potatoes. For millions of people in Ireland, the lumper potato became the main source of food. Before 1800, many kinds of potatoes, as well as grains and vegetables, were grown in Ireland for everyone. By 1800, 90% of Ireland's people lived almost entirely off of lumper potatoes.

In the wild, hundreds of different kinds of potatoes grow together. Bumblebees carry pollen from one potato plant to another to help them reproduce. But farmers grow potatoes differently. Farmers take a potato and cut out a small section. They then plant this section to grow a new potato plant. This produces potatoes that are genetically identical to their parents. The new potatoes are actually clones of the ones they grew from. By 1845, identical lumper potatoes filled the fields of Ireland.

In 1845, a fungus from North America called "late blight" accidentally arrived in Ireland. This fungus grew on the lumper potatoes. Farmers dug the potatoes out of the ground, and within a few days, the potatoes turned into a slimy, black mess. Other varieties of potatoes have genes that resist blight. Because the lumper potatoes were genetically identical to one another, none of them had the genes to resist the fungus. Mutation would still provide some genetic variation in the potato population; however, in 1845, 40% of the potato crop failed, and by 1846, blight destroyed 100% of the lumper crop. In Ireland, this period of time is known as "The Great Hunger." An estimated one-and-a-half million people died of starvation and disease because of the blight. This represented 1 out of every 8 people in Ireland.

Other countries experienced blight, too. In the United States, Canada, and in other parts of Europe, blight killed lumper potato crops. These places did not experience severe starvation, because farmers there grew other potato species. Other species survived because they still had enough genetic variation, including some potatoes with a genetic trait that could resist blight.




*Susceptibility to blight*

# Northern Elephant Seal

The Northern elephant seal lives in the North Pacific Ocean, from Baja, Mexico to the Gulf of Alaska. This seal is the second largest seal in the world. Adult males can grow to over 13 feet long and weigh up to 4,500 pounds. These seals spend their breeding season on a few remote beaches and islands in California and Mexico. During the rest of the year, they live in the open ocean.

In the 1700s and 1800s, hunters killed thousands of elephant seals. They mainly used their blubber, or fat, as lamp oil. By 1892, there were only 20–100 elephant seals left in the world bred on just one island off the coast of Mexico. The Mexican and United States governments began to protect these seals. Those few seals that were left reproduced. The population of elephant seals grew rapidly.

There are now over 150,000 elephant seals. All of these seals came from those few ancestors who were protected—the 20–100 seals that lived in 1892. This means that the current population of seals have very little genetic variation, because they all came from such a small number of parents. Even though there are many seals alive today, some scientists are concerned that they could become extinct. With the small amount of genetic variability in the gene pool that random mutations provide, these seals don't have as many potential adaptations available. Scientists worry that a change in the environment, such as a new disease, could kill all the seals. If one seal does not have the genes to fight a new disease, other seals are also unlikely to have them.

*Northern elephant seals*

# Sweet Vernal Grass

Sweet vernal grass has a vanilla-like smell when it is cut. Because of this pleasant scent, many people like to plant it. This grass originally grew in Europe and Asia, but now has spread throughout the Americas and Africa. Sweet vernal grass can be found in many counties in California. Scientists have studied this grass because it seems to survive in a wide variety of environments.

In the 1800s, miners in the United Kingdom mined lead and zinc at the Trelogan mine. In the process, miners left piles of mine tailings. Tailings are a byproduct of mining; they are the materials that are left over after miners have finished processing the metals they take out of the ground. These tailings are still around today, and as a result, the soil near the mine has high levels of zinc and lead. Farther away from the mine, the soil does not have these metals. Sweet vernal grasses grow in both of these places.

*Sweet vernal grass*

Scientists have studied the sweet vernal grass that grows at the Trelogan mine as well as at other mines. They have discovered some amazing differences in the grasses. The grasses that grow on the tailings have a high tolerance for  metals. These grasses actually die when they are grown without metals. In contrast, the grasses that grow away from the tailings cannot tolerate metals in the soil.

These two populations of grasses have changed over time in another way. They produce flowers at different times of the year. Pollen from grasses is spread by the wind. Pollen blows from the flowers of one plant to the flowers of another in order to reproduce. Now that the two populations of grasses develop flowers at different times of the year, pollen cannot spread between the type that lives near the mines and the type that lives far away. This means the two types of grasses can no longer reproduce together. Reproducing at different times might be a favorable adaptation for the grass. Because each population can only survive well in its own kind of soil, breeding with the other population would bring the genes into the population that would prevent offspring from surviving. Over time, these populations of grasses may evolve into two separate species.

Name: _____

## Directions:

1. Use your **Resource Reading** to complete the chart below for your species.

2. Complete the other portions of the chart based on presentations in your new group. (1 point for each cell)

| | Greater Prairie Chicken | Lumper Potatoes |
|---|---|---|
| **List the human activities that have affected this species.** | | |
| **How did human actions cause this species' environment to change?** | | |
| **Did human actions cause genetic variation in this species to change? How?** | | |
| **What was the effect of these changes on the evolution of this species?** | | |

Name: _____

| | Northern Elephant Seals | Sweet Vernal Grass |
|---|---|---|
| **List the human activities that have affected this species.** | | |
| **How did human actions cause this species' environment to change?** | | |
| **Did human actions cause genetic variation in this species to change? How?** | | |
| **What was the effect of these changes on the evolution of this species?** | | |

# Wild Bananas

Name: _____

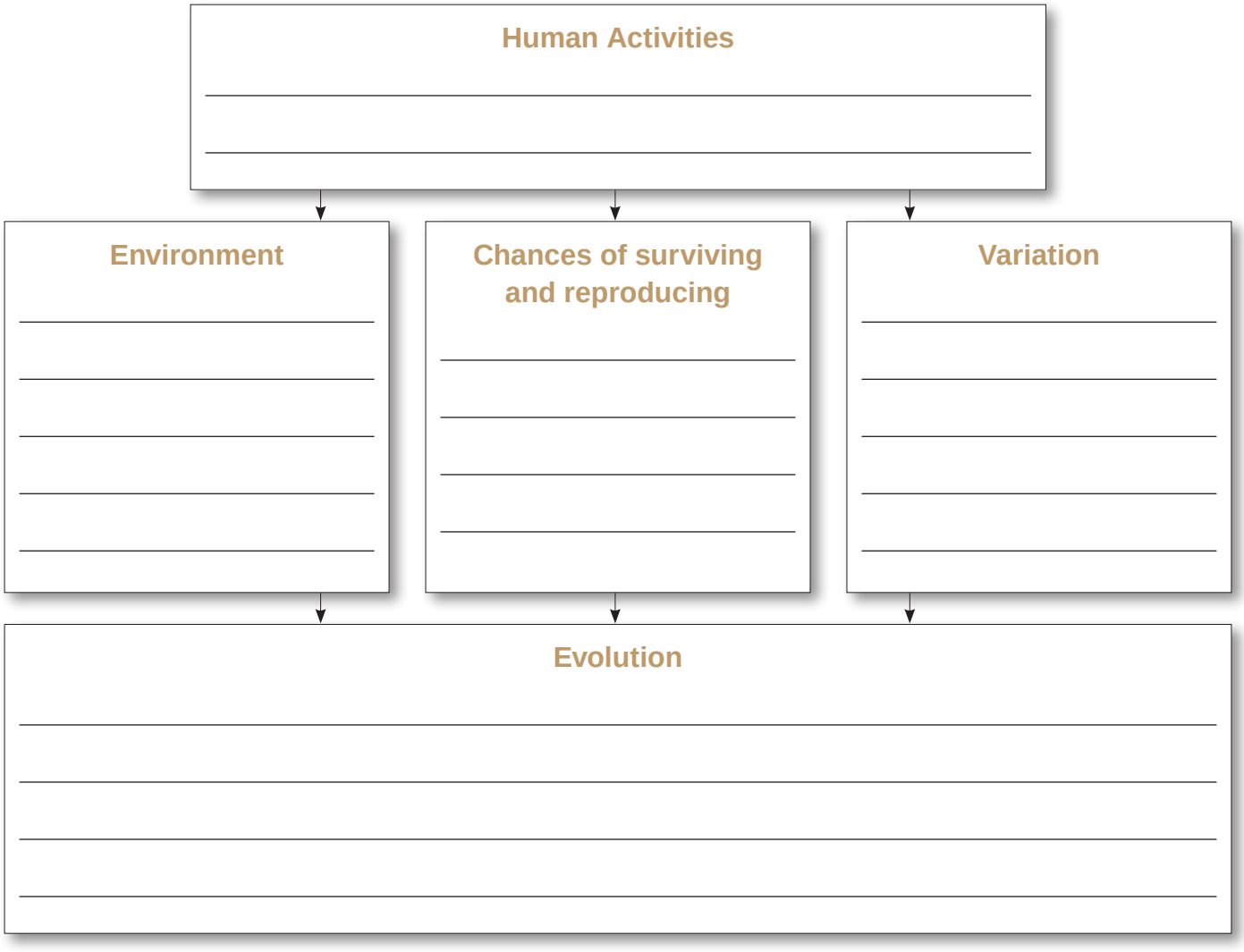
## Part I. The Pupfish

**Directions:** Complete the two flowcharts below, one for each species of pupfish. (5 points each)

- In the first box: describe the kinds of human activities that have affected these fish. Think about how these activities have affected the species.
- In the next box, describe how the species' environment has changed.
- In the next box, describe how the species' chances of surviving and reproducing have changed. In the next box, describe the species' level of genetic variation. If humans altered this level of variation, how did that happen?

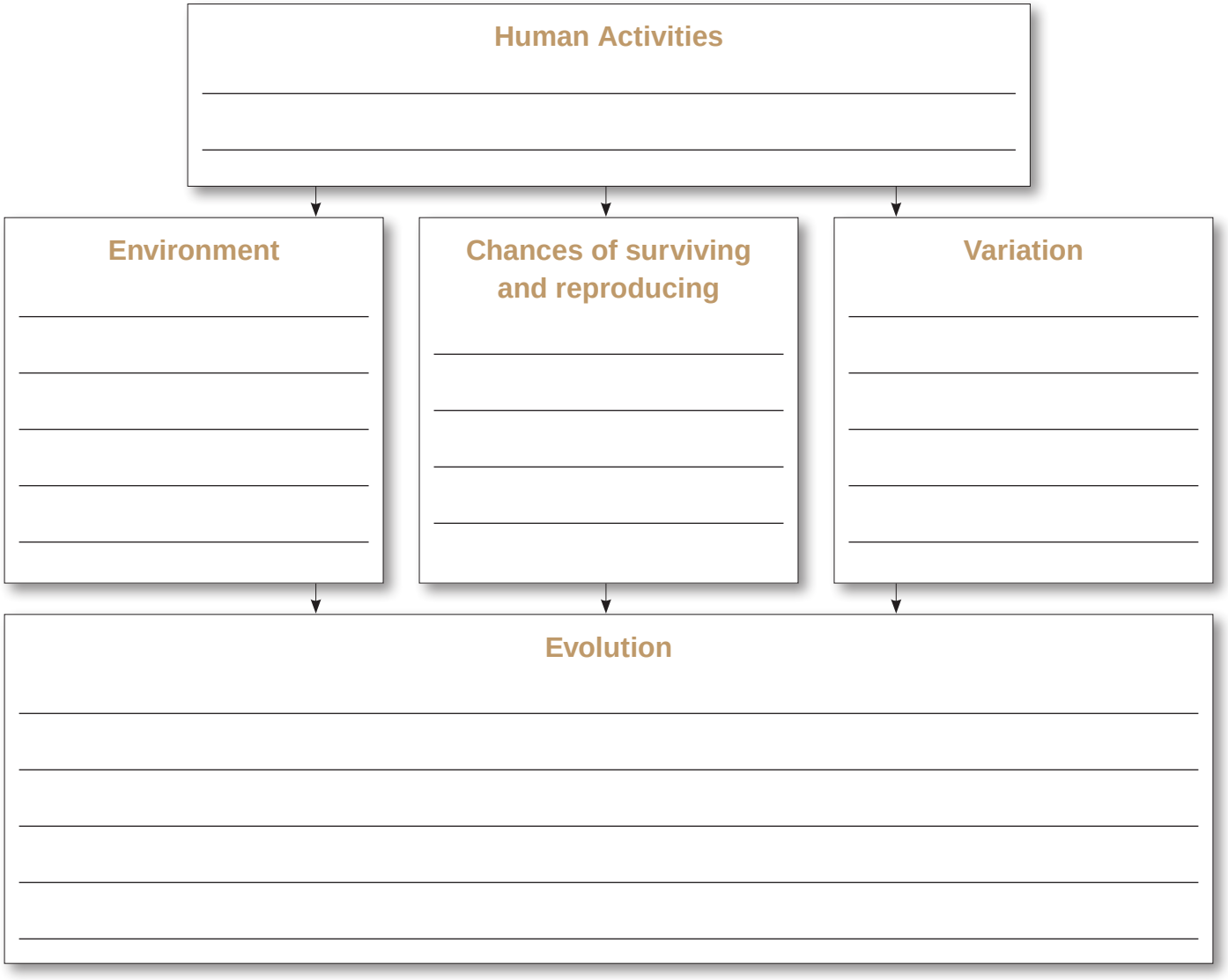
Finally, write 3–4 sentences in the last box to summarize how human activity has affected the evolution of each species of pupfish. Use the word "adaptation" in your paragraph. (5 points)

### The Tecopa Pupfish



Name: _____

## The Desert Pupfish



Name: _____

## Part II

**Directions:** Read the following list of species and of human activities that have influenced their evolution. Circle one of these to use for the flowchart below.

| Species | Human Activity |
|---|---|
| **American pika** | Many activities, including driving cars and running factories, have put gases such as carbon dioxide into the air. These gases have caused the temperature on the planet to increase. |
| **El Segundo butterfly** | Developers destroyed much of the coastal dune environment near Los Angeles. Recently, they have started planting coastal buckwheat plants along the remaining dunes. |
| **Field crickets in Kauai** | Humans brought the fly *Ormia ochracea* to Kauai. |
| **McDonald's rockcress** | People mine mountainous areas that contain heavy metal. In the past, people have mined nickel in the area where McDonald's rockcress lives. People also drive off-road vehicles in the mountains. These can crush plants. |
| **Purple pitcher plant mosquitoes** | Many activities, including driving cars and running factories, have put gases such as carbon dioxide into the air. These gases have caused the temperature on the planet to increase. |

Complete the flowchart for one of the species above. First, describe the kinds of human activities that have affected this species. Think about how these activities have affected the species. In the next box, describe how its environment has changed. Then, describe how its chances of surviving and reproducing have changed. Then, describe its level of variation. If humans altered this level of variation, how did that happen? Finally, write 3–4 sentences in the last box to summarize how human activity has influenced evolution for each this species. Use the word "adaptation" in your paragraph.

Name: _____

**Species:** _____

## Human Activities

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## Environment

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## Chances of surviving and reproducing

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## Variation

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## Evolution

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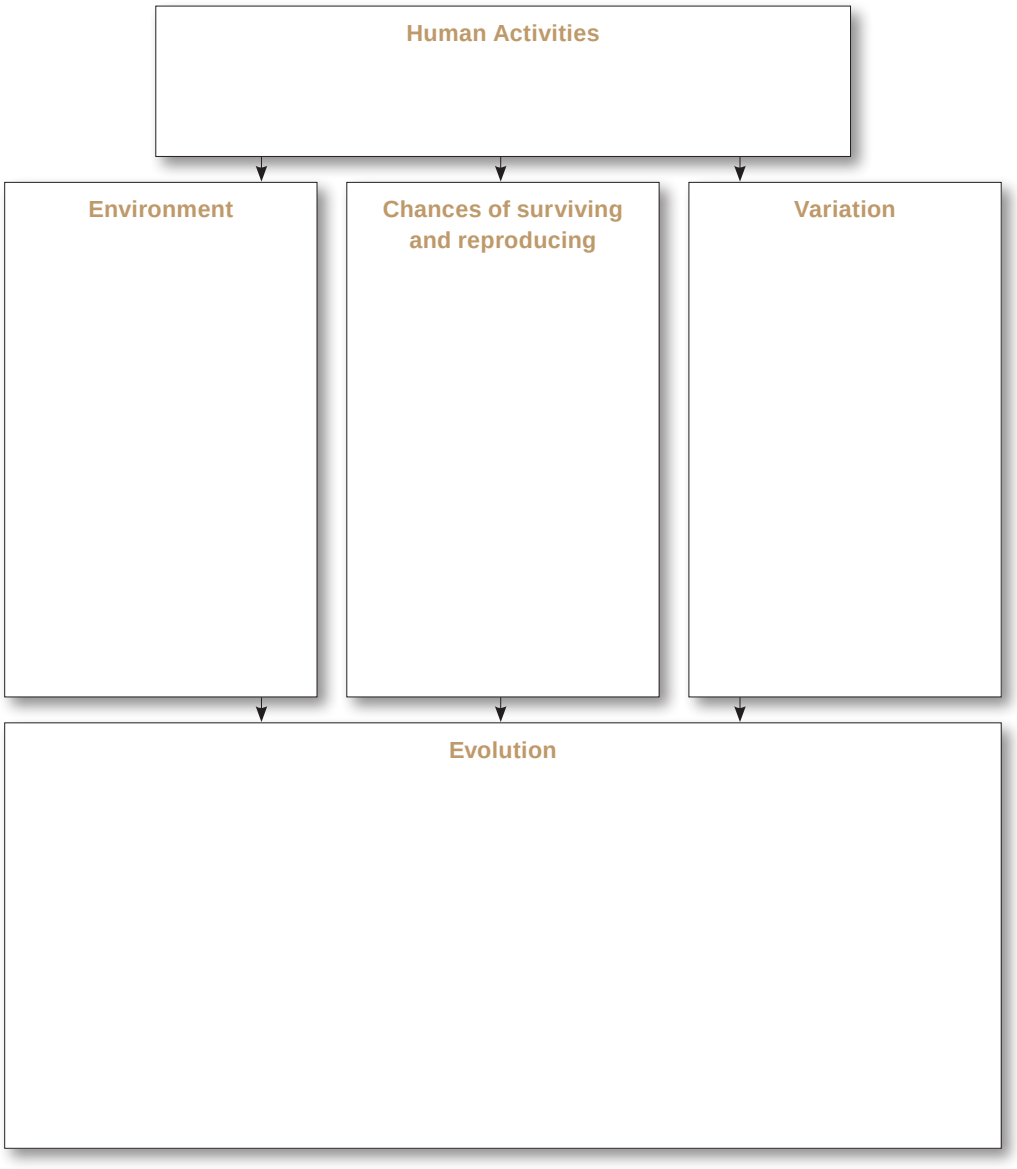
# Human Influence on Evolution

**Species:** _____



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